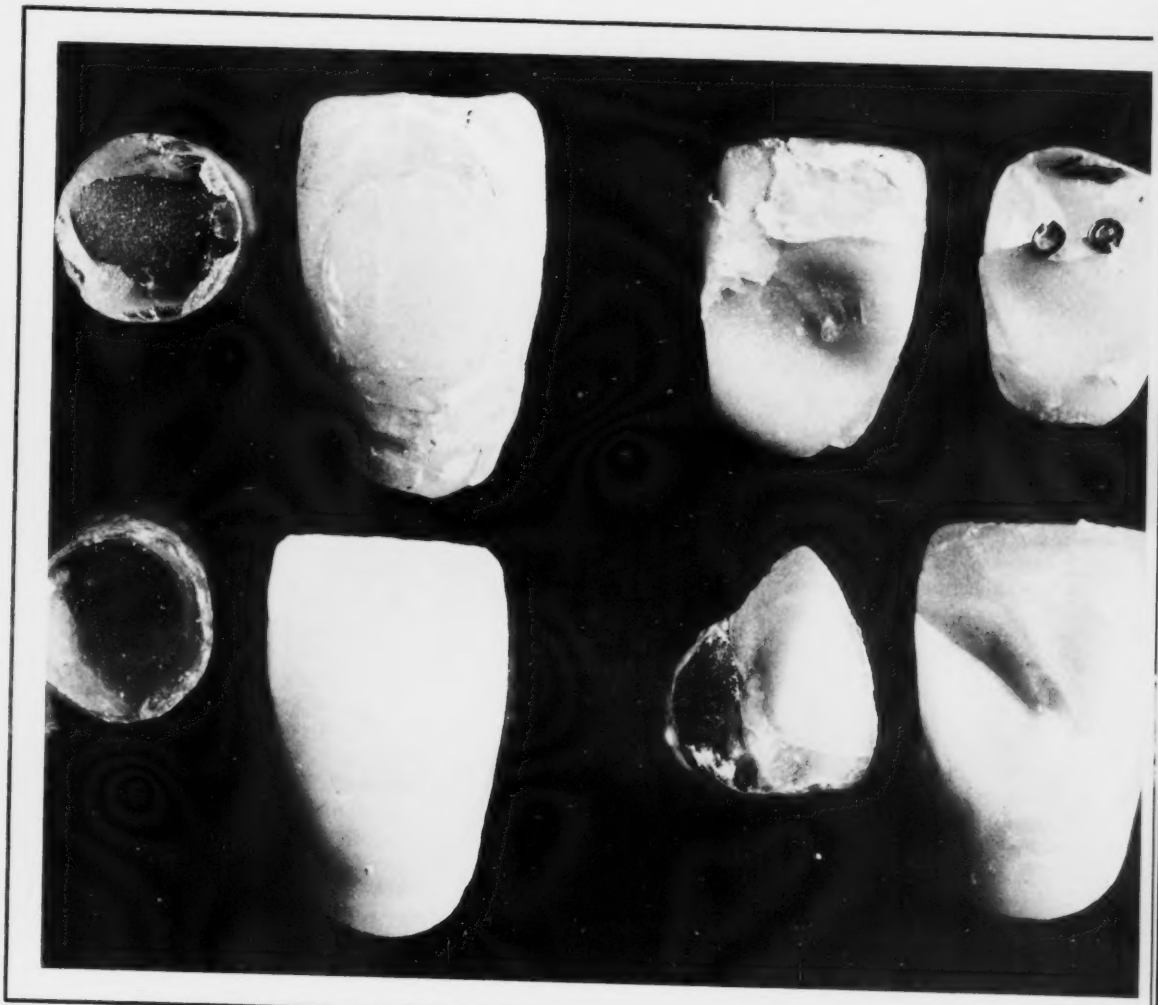
NATIONAL BUREAU OF STANDARDS

*April/1967*

# Technical News Bulletin





U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

# TNB Technical News Bulletin

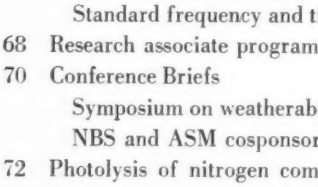
APRIL 1967/VOL. 51, NO. 4/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
Alexander B. Trowbridge
Acting Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

## CONTENTS





**COVER**

*Specimens and resin rods (left of each tooth) used to determine the strength of a new method of fastening porcelain teeth to plastic denture bases. One specimen (lower left) was untreated and did not adhere to the rod; the others broke before the bond failed* *(see page 65).*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—
- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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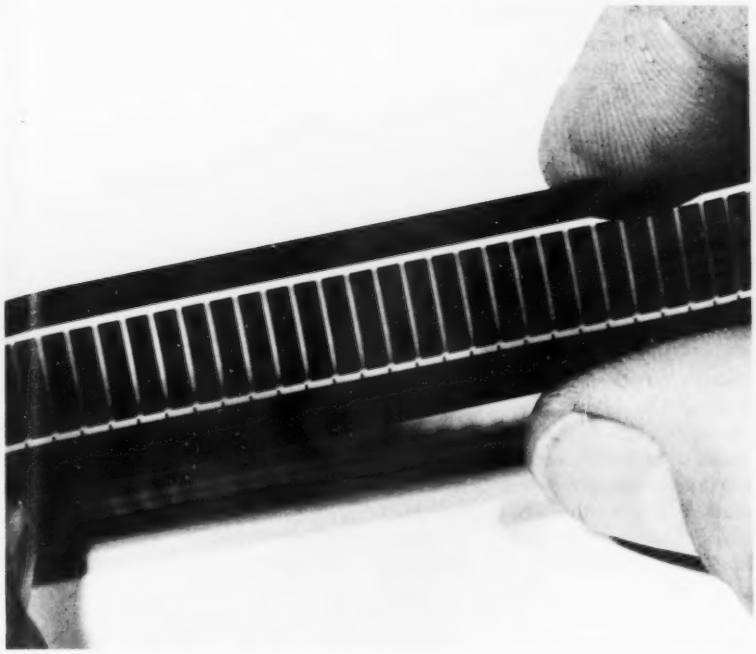


# FOSDIC IV Reads Microfilmed Weather Data for Computer

*The image of each punched card on the microfilm positive has been so reduced vertically. The small spike beside each card image is the frame index, essential for precise registration of the scan with the image.*

An improved model of FOSDIC—*F*ilm *O*ptical *S*ensing *D*evice for *I*nput to *C*omputers—has been completed by the National Bureau of Standards for use with the computers of the National Weather Records Center at Asheville, N.C. FOSDIC IV, designed under the direction of Ervin C. Palasky of the NBS Measurement Engineering Division, reads data on past weather conditions from microfilms of punched cards from the Center's archives. The machine performs logical operations on the data it reads and also selects certain data to be recorded on magnetic tape for later input to digital computers. This will enable past weather conditions to be compared with more recently gathered data, so that the Center can study long-range weather patterns and improve its present prediction services.

The first FOSDIC [1] was produced by NBS for the Bureau of the Census to read marked documents in experimental and special data processing applications. NBS later produced FOSDIC II to enable the Weather Bureau to duplicate microfilmed punched cards, FOSDIC III for use in the 1960 census, and a partially transistorized version in ACCESS (*A*utomatic *C*omputer *C*ontrolled *E*lectronic *S*canning *S*ystem) for the Office of Emergency Planning.[2]

The newest model, FOSDIC IV, also is partially transistorized and in design is especially adapted for rapid scanning and selection of data, reading from microfilms of punched cards at the rate of 2 million bits per minute, compared to the 500,000 of FOSDIC II. This rate corresponds to a column-by-column examination of 2,000 full cards per minute and up to 8,000 cards per minute when examining fewer columns.

FOSDIC IV can also re-sort input data—as in performing computations producing new data—whereas its predecessor FOSDIC II could only duplicate selected cards in their entirety. Data to be recorded are translated into the most suitable code for recording on magnetic tape and subsequent use by computer.

### Microfilming Punched Cards

The weather data of the National Weather Records Center are contained on 400 million punched cards which are now being microfilmed to take advantage of the greater data density of microfilm and the rapid access obtained by use of FOSDIC. The cards are photographed with an anamorphic lens which reduces card size by a factor of 43-to-1 vertically and 24-to-1 horizontally, compressing the image so that the rectangular punches appear as 0.06-mm squares.

The images run across the 16-mm microfilm, appearing as narrow bands numbering approximately 11 card pic-

*continued*

## FOSDIC IV *continued*

tures to the inch. The cards are filmed at a rate of 800 per minute through a continuous flow filmer developed at the Bureau of the Census. Each 100-foot reel of microfilm holds the images of up to 12,000 punched cards. The microfilm negative is retained in a master file after a positive film is produced for the working copy. On the working copy films, the punched holes appear as transparent spots surrounded by the opaque background of the card stock.

### Flying Spot Scanner

The data contained on a microfilm frame are probed by projecting the image of the face of a cathode-ray tube (CRT) through the film. The light transmitted by the microfilm image at successive positions of the luminous CRT spot is sensed by a photoelectric cell. If the CRT scan is controlled to run down each column of the microfilmed card, it will produce as a signal a running measurement of the transmissivity of the microfilm along the scan when compared to a threshold, in effect, a series of digital data contained on the card. The scan may be contrived to examine only areas of interest by programing the motion of the CRT beam.

*The data obtained from microfilm being threaded onto film transport by Camilla Deragon will be recorded on magnetic tape (left); the other racks contain logic, memory, scan control, and film advance circuitry. Data selection and logical manipulation are determined by the wiring on the plugboard.*

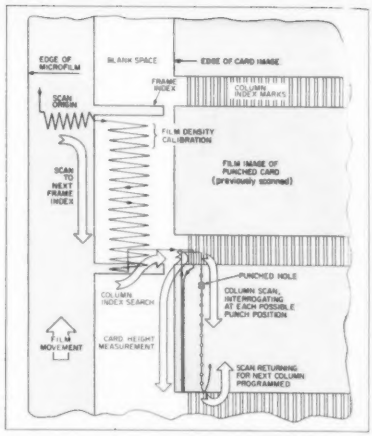
Scanning must be extremely accurate in order for the beam to pass through each punch despite variations in card position. This accuracy is obtained by reference to the top edge of the card for vertical registration and to column marks for horizontal registration, as a card is normally viewed. This is accomplished by moving the beam, after each scan, across the film to the left edge of the frame area and down until it reaches the index mark of the next card, at the same height as the top edge of the card. The vertical height of each card is then measured in a preliminary sweep to enable FOSDIC to take into account slight variations in size produced by the high-speed, continuous-flow filmer.

The beam is moved across the column index marks until it reaches a column programed for examination and then downward from the top of the card, which is the vertical reference for subsequent data location. The film opacity is interrogated at each of the 12 possible punch positions in the column and all punches on the card are stored as digital data in a real time memory. Data selected for recording, as a result of logical examination, are passed on to another memory, an 80-column register, from which they are transferred to magnetic tape.

### Date Acceptance

The card columns scanned and the data selected from them are determined by the wiring of FOSDIC's 2,560-hole plugboard, as is the logical treatment the data are subjected to. The plugboard is removable, so that FOSDIC can be programed to read and treat the data for different programs or cards by merely inserting the proper plugboard.

FOSDIC IV has a more extensive bank of logic elements than previous




*FOSDIC's scan must register precisely with card punch marks on the microfilm; this is accomplished by reference to the frame indexes. The broad arrows show FOSDIC's scan pattern.*

FOSDIC models, allowing more editing, shifting, and compacting operations to be performed. These logic operations are carried out by circuitry capable of making 240 *AND* or *OR* decisions during each card scan. At this stage the data can be shifted, constants entered, and new data entered, from reduction or combination of the original data as programed by the plugboard.

When the 80-column storage register is full the contents are passed serially through a converter for translation from 12-bit Hollerith to 6-bit-plus-parity binary or binary-coded-decimal, whichever is compatible with the next computer operation. Then the data are recorded on magnetic tape, which runs only during such recording operations.

### Error Suppression

During normal sensing the microfilm moves continuously, but can be stopped on operator command or when the logic identifies an invalid data combination, incomplete data, or cards having certain preselected data combinations. The card at which the

operation stops is presented for the operator's inspection on a viewing screen and its data content is indicated by a bank of lights. The operator can enter a correction if he wishes and then trigger the machine to resume operation.

[1] Earlier versions of FOSDIC are described in **FOSDIC III to assist in 1960 census**, NBS Tech. News Bull. **43**, 106–107 (June 1959). **FOSDIC II reads microfilmed punched cards**, NBS Tech. News Bull. **41**, 72–74 (May 1957), and **FOSDIC—a film optical sensing device for input to computers**, NBS Tech. News Bull. **38**, 24–27 (Feb. 1954).

[2] **Direct communication between man & computer**; ACCESS system will process emergency data, NBS Tech. News Bull. **50**, 53–54 (Apr. 1966).

# Chemical Bonding Gives Stronger Dentures

The National Bureau of Standards, in cooperation with the American Dental Association, has developed a method of bonding porcelain teeth to plastic denture bases. This development makes the denture stronger and prevents odor-causing food and bacteria from seeping between the teeth and the plastic denture base.

The bonding method resulted from an investigation [1] recently completed by Dr. G. C. Paffenbarger, American Dental Association Senior Research Associate at the NBS Institute for Materials Research. This work, supported by the U.S. Public Health Service through a grant from the National Institute of Dental Research, shows that a silane coupling agent (gamma-methacryloxypropyltrimethoxysilane) may be used to form a strong bond between porcelain teeth and acrylic resin denture bases.

Dentures are usually made by attaching the front porcelain teeth to a plastic base by gold alloy pins. The back teeth are then mechanically locked in place by canals and undercut wells. The resulting dentures are somewhat weaker than need be because porcelain teeth do not bond to the denture base. In addition, the lack of any true chemical bonding of the porcelain teeth to the denture base allows seepage of food and bacteria between the teeth and the plastic base. This often causes an unsightly appearance as well as poor mouth hygiene.

Dr. Paffenbarger predicts that use of the silane coupling agent will have a large impact upon the dental tooth industry which manufactures over 60 million porcelain teeth annually in the United States. Approximately 20 million of these are front teeth with gold pins. The elimination of the gold pins alone, costing approximately 40 cents a tooth, would mean a savings of roughly $8 million annually.

Adhesion tests of the silane-treated porcelain teeth and the plastic base have invariably shown no rupture of the tooth-plastic joint. In tests to failure, the porcelain teeth broke before the bonded joint pulled apart.

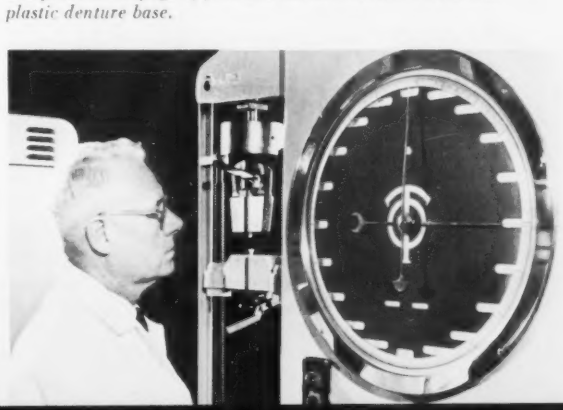
In the NBS adhesion tests, a tensile specimen was prepared similar to the American Dental Association specification No. 15.[2] The teeth were cleaned by washing three times in a boiling solution of a household detergent, and rinsed in hot water. After cleaning, the teeth were placed in 0.5 percent solution of the silane in distilled water. The solution was acidified with acetic acid to a pH between 3 and 4 and continuously stirred. Acidification catalyzes hydrolysis and prepares the silane for bonding to the surface of the porcelain tooth. The hydrolysis reaction was allowed to continue for 1 hour. The teeth were then removed and dried for 10 minutes in an oven at 110 °C. After this treatment the teeth were inserted into the mold in which the tensile specimens were formed.

Bonded and nonbonded teeth were also tested for seepage between teeth and plastic base. In these tests, dentures were made of clear plastic and submerged in dye solutions under a vacuum. It was clearly demonstrated that there was no seepage between the bonded teeth and the plastic base whereas there was severe seepage when nonbonded teeth were used.

[1] For further details, see **Bonding porcelain teeth to acrylic denture bases**, by G. C. Paffenbarger, W. Timothy Sweeney, and R. L. Bowen, J. Amer. Dental Assoc. (to be published).

[2] American Dental Association, Guide to Dental Materials, ed. 3, Chicago, American Dental Association, 1966.

*Dr. G. C. Paffenbarger tests the strength of a silane bonding agent applied between a porcelain tooth and a resin rod. Tests show that the silane bonding agent gives stronger denture construction and prevents seepage of food and bacteria between teeth and plastic denture base.*



# Data Obtained for Optical Design

**Absorption Coefficients of Calcium Fluoride Evaluated at Elevated Temperatures**

Calcium fluoride is widely used in the design of optical components and systems. Applications in infrared and ultraviolet optical devices are becoming increasingly important, particularly in military detection and guidance systems and in space research.

To facilitate the design and application of these optical systems, W. Fussell and J. Geist of the NBS Institute for Basic Standards recently evaluated the normal spectral absorption coefficients of single-crystal and polycrystalline calcium fluoride at temperatures up to 600 °C. In this study,[1] which was supported by the Advanced Research Projects Agency, the absorption coefficients were determined for wavelengths of 6, 8, and 10 microns.

It has been shown [2] that the normal spectral emissivity of a specimen is a function of its normal spectral absorption coefficient, its normal spectral surface reflectance, and its thickness. Thus, by measuring the emissivity, computing the reflectance, and using specimens of known thickness, sufficient data were obtained to calculate absorption-coefficient values.

The normal spectral emissivity of a sample, at a given wavelength and temperature, is the ratio of its spectral radiance in a direction perpendicular to its surface, to that of a blackbody at the same temperature. In this study, an infrared recording spectroradiometer was used to obtain three readings, alternately, of the specimen and the blackbody. The 3 blackbody readings and the 3 sample readings were then averaged separately. The ratio of the average sample value to the average blackbody value was accepted as the value of normal spectral emissivity for the sample at the wavelength and temperature of the test.

For these measurements the sample and blackbody were heated in separate cylindrical electric ovens. Both ovens were mounted on a single lathe bed so that either oven could be placed in the field of view of the spectroradiometer. The specimen and the blackbody were each heated to the desired temperature, then held at a temperature constant to within 0.5 deg C for all measurements.

Three samples each of single-crystal and polycrystalline $CaF_2$ in the form of 3.175-cm-diameter disks were evaluated. The single-crystal specimens were 2.1, 8.1, and 16.1 mm in thickness. The polycrystalline specimens had thicknesses of 1.1, 3.2, and 6.5 mm. Normal spectral emissivity of each sample was measured at 500±2 and 600±2 °C at wavelengths of 2, 4, 6, 8, 10, and 12 microns. The wavelength bandwidths varied from a maximum of 0.14 micron at 12 microns at 500 °C to a minimum of 0.06 micron at 4 microns at 600 °C.

The reflectance values of the specimens were computed [3] from their refractive indices at room temperature. These values were then extrapolated to the temperatures of the measurements. It was assumed that the rate of change of the refractive indices, and therefore the reflectance values, would remain constant from room temperature to 600 °C. This assumption may not be correct; however, the values of reflectance are very small, on the order of 0.03 at most. Therefore, even large proportional errors in the computation of reflectance would not have a significant effect on the computed values of absorption, because the estimated errors in the measured emissivity values are of the same order of magnitude as the reflectance values.

The results of the study show that the absorption coefficients increased markedly with temperature. It was also found that the normal spectral absorption coefficients of the polycrystalline calcium fluoride were consistently higher than the corresponding values for the single-crystal specimens although this may be caused by scattering. In addition, there was approximately an order of magnitude increase with temperature in the spectral absorption coefficients between room temperature and 600 °C.

From an analysis of all known sources of errors, it is estimated that the system as described has the capability, in various materials, of yielding normal spectral emissivity data of sufficient accuracy to allow computation of normal spectral absorption coefficients accurate to 5 percent of the absorption value at wavelengths from 2 to 12 microns.

[1] For further details see, Approximate normal emissivity spectra in the infrared at elevated temperatures of samples of $CaF_2$ and IR–3, by W. Fussel and J. Geist, Applied Optics (Jan. 1967).
[2] H. O. McMahon, J. Opt. Soc. Am. **40**, 376 (1950).
[3] I. H. Malitson, Applied Optics **2**, 1103 (1963).

*Apparatus used to determine the absorption coefficient of calcium fluoride at elevated temperatures. J. Geist positions an oven in front of the spectroradiometer used in the investigation.*

# STANDARDS AND CALIBRATION

## NEW GRADUATE PROGRAM IN RADIO METROLOGY

The Radio Standards Laboratory (RSL) of the NBS Institute for Basic Standards is cooperating with the University of Colorado at Boulder to establish a new option in the university's graduate program in electrical engineering. Major goals of the program are to provide a sound preparation for future work in radio metrology and the opportunity to engage in thesis research and radio metrology problems at RSL in Boulder, Colo. The program permits employers, especially heads of standards laboratories, to improve the basic competence of staff members who must meet the growing needs for precision measurement, quality control, and standards in the electromagnetic area.

Students in this program will receive instruction in the sciences on which standards are based and on the present state of the art. They will study principally in the Electrical Engineering Department of the University of Colorado and so must meet the regular university requirements for graduate study in this department. A particular study program will be determined by agreement between each student and his adviser, with the advice and consent of the graduate faculty in electrical engineering. A thesis is usually required, but in special cases the thesis requirement may be waived to allow additional course work or independent study.

Participation by the National Bureau of Standards gives students the chance to do their research in association with the NBS staff, in context with current NBS efforts, and with the use of NBS facilities. These facilities include an excellent radio science library with extensive acquisitions in the basic physical sciences, mathematics, and engineering; a large computer and staff programers; and an instrument shop that specializes in building experimental apparatus. Students will accomplish their thesis work under NBS adjoint professors in electrical engineering and projects of interest to the students, the university, and NBS. Attendance at seminars of the RSL is an integral part of the activities.

The program will be offered starting with the fall term of 1967, which begins on September 18. Application forms and full information may be obtained from: Dr. Norris S. Nahman, Radio Standards Laboratory, National Bureau of Standards, Boulder, Colo. (Dr. Nahman is adjoint professor in electrical engineering at the University of Colorado.)

## CALIBRATION OF RADIOACTIVE SAMPLES

The Radioactivity Section of the NBS Institute for Basic Standards has recently revised the schedule of its calibration services for alpha-particle, beta-ray-, and gamma-ray-emitting samples of radioactive materials.[1] The services have been extended to include calibration of strontium-89 for beta-ray emission, and cerium-139 and cerium-141 for gamma-ray emission. Fees have generally been revised upward to yield full recovery of the cost of providing the services.

## STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz
WWVH—2.5, 5.0, 10.0, and 15.0 MHz
WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT (7:00 p.m., e.s.t.) on the first day of a month. There will be no adjustment made on 1 May 1967. The pulses occur at intervals that are longer than one second by 300 parts in $10^{10}$ due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France.

Radio Station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS–III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. There will be no adjustment made on 1 May 1967.

[1] Federal Register 31, 16186 (Dec. 17, 1966).

# Research Associate Program Expands

*Developing information on the value of standards to ADP users is the concern of Research Associate S. F. Buckland.*

(Top) *NBS Research Associate Albert L. Gugeler is studying the microstructure of an enamel-metal system.*

(Bottom) *A study of the performance of mortars with organic additives is a Research Associate Project being conducted by Dallas Grenley.*

Increased emphasis on the Research Associate Program at the National Bureau of Standards over the past year has brought several additional industrial organizations and trade associations into closer relationship with the Bureau.

Sponsors of new Research Associates who have recently started projects at NBS include AiResearch Manufacturing Co., American Cyanamid Co., Control Data Corp., Dow Chemical Co., International Business Machines Corp., Ferro Corp., The Procter & Gamble Co., and the St. Louis-San Francisco Railway Co. Research associates sponsored by these organizations normally spend full time at NBS working toward the solution of basic problems of interest to the scientific and industrial communities.[1] NBS makes its expertise and facilities available to guide and assist the Research Associates in their work, while the sponsoring company or trade association pays their salaries and subsistence. The newly added programs illustrate the scope and diversity of joint research now being conducted at NBS.

At the Boulder, Colo., laboratories, Anthony U. Simpson, a Research Associate sponsored by AiResearch Manufacturing Co., is working with the Cryogenics Division of the Institute for Materials Research to obtain information on the properties of the solid particles that form in vents as spacecraft release vapor from cryogenic liquids into space. Under these conditions, explosive mixtures may form, pressures may fluctuate rapidly, and plugging of passages or fouling of equipment may occur—problems which the aerospace industry is understandably anxious to solve. Mr. Simpson has developed preliminary analytical methods through which the heat transfer characteristics of a subliming solid-vapor mixture can be calculated with useful accuracy. An effective experimental system has now been constructed to photograph and measure the size of the solid particles, and the phenomena involved in the venting of such gases to vacuum are as a result becoming better understood.

William Hodgson, a senior physical chemist with the American Cyanamid Laboratories at Stamford, Conn., is analyzing the programs of the NBS Institute for Materials Research from the viewpoint of an industrial research scientist, and will in turn inform the Institute staff of the usefulness of advanced research and measurement

techniques to industry. As a Research Associate, he will also conduct laboratory research in his own field of specialization—spin resonance of single crystals.

Public Law 89-306, better known as the Brooks bill, assigns to the National Bureau of Standards a comprehensive responsibility for establishing standards to govern the widespread use of data processing systems by the Federal Government. A Research Associate Program directed toward the development of standards proposals has recently been undertaken by Stanley F. Buckland under the sponsorship of Control Data Corp. In this program, a natural adjunct to the work of the NBS Center for Computer Sciences and Technology, Mr. Buckland is developing both qualitative and quantitative information on the value of standards to ADP users, and is surveying user, manufacturer, and data transmission requirements for compatibility in data interchange. The possible impact of standards on capital and operating costs of Federal ADP installations is also being studied.

In the Building Research Division of the NBS Institute for Applied Technology, Dallas Grenley of Dow Chemical Co., is evaluating the performance of mortars modified with organic additives. A related Research Associate Program sponsored by the Structural Clay Products Institute (SCPI) has had as its objective the development of test procedures that will enable correlation of laboratory test procedures and field performance of brick walls. The SCPI program provides, as a natural byproduct, data for comparison between conventional mortars and modified mortars such as those being studied under the Dow-sponsored Research Associate Program.

Under the sponsorship of International Business Machines Corp., Carl Shelton has embarked on a Research Associate Program related to the photometry of phosphors. This program, conducted in the Metrology Division of the NBS Institute for Basic Standards, has as its objective the standardization of techniques for measurement of such characteristics as spectral emission, time response, brightness, and aging. With the growing use of phosphors in such applications as aircraft instrument panels and computer displays as well as in such established applications as cathode ray tubes and fluorescent illumination, these characteristics become increasing important.

Albert Gugeler, a Research Associate supported by the Ferro Corp., has begun a study of the adherence characteristics of porcelain enamel as applied to metals, particularly aluminum. A principal use of such coatings is in the architectural field, where they are employed to provide permanent color. Since it is believed that the spalling or chipping which sometimes occurs after the coated panels are put into service is a consequence of poor adhesion of the enamel to the metal, the study takes on particular importance. Mr. Gugeler's work is an expansion of the long-established Research Associate Program sponsored in the NBS Building Research Division by the Porcelain Enamel Institute.

The Procter & Gamble Co. is sponsoring Alton J. Mabis in a Research Associate Program to develop methods for growing large, highly perfect single crystals of long-chain triglycerides. If these materials—basic constituents of such common things as cooking fats and oils—can be obtained in this fundamental form, it will permit a more effective determination of their important physical properties. The program is centered in the Crystal Chemistry Section of the NBS Institute for Materials Research.

Two Research Associates, Lyle Reed and Raju Gokaraju, sponsored by the St. Louis-San Francisco Railway, are working in the Technical Analysis Division of the Institute for Applied Technology to increase the usefulness of a computer simulation model of a railroad network. Working with the model originally developed at the Bureau by William P. Allman, the Research Associates are striving to expand its capability in response to demands from the railroad industry at large for a still more effective tool for evaluating railroad operating policies. The network analysis made possible by such a model permits testing "on paper" the effects of alternative decisions on such matters as train size, schedules, routing, classification, and grouping of freight cars.

The NBS Office of Industrial Services is the focal point for Research Associate Program development and its coordination between industry and the Bureau. This office is effecting liaison with an increasingly diverse cross section of industry and trade associations to make these companies and organizations aware of the many opportunities and services offered by NBS, and to increase the interaction between the Bureau and industry to the mutual benefit of both.

[1] See **NBS broadens collaboration with industry**, NBS Tech. News Bull. **50**, No. 2, 26–27 (February 1966).

*A computer simulation of a railroad network such as shown is expected to permit the testing "on paper" of alternative decisions affecting train size, schedules, routing and grouping of freight cars.*

# CONFERENCE *Briefs*

## SYMPOSIUM ON THE WEATHERABILITY OF PLASTICS

A symposium on the Weatherability of Plastic Materials was held on February 8–9, 1967, at the Gaithersburg, Md., facilities of the National Bureau of Standards. The symposium, jointly sponsored by the Manufacturing Chemists Association (MCA) and the Bureau, was attended by more than 300 scientists and engineers from industry, government, and educational institutions.

John P. Eberhard, Director of the NBS Institute for Applied Technology, welcomed the participants to the Bureau.

The purpose of the symposium was to review and highlight significant activities in the evaluation of the weatherability of plastic materials, and to provide an opportunity to introduce new developments and approaches toward the prediction of outdoor durability of plastics.

The 20 technical papers presented at the symposium on the Weatherability of Plastic Materials were divided into 4 general categories:

1. Measurement of the chemical and physical changes occurring in plastics.
2. Measurement of the radiant energy flux present in natural or artificial weathering tests.
3. Mathematical analysis of weatherability data.
4. Natural and laboratory weathering tests of specific plastic formulations.

Measuring degradation in plastics was the subject of six papers. H. H. G. Jellinek of the Clarkson Institute of Technology discussed the fundamental chemical degradation reactions that can occur in "pure" polymeric systems. Some of the exposure variables that cause chemical degradation of plastics and some of the chemical and physical changes involved were described by F. H. Winslow of the Bell Telephone Laboratories. V. E. Gray of the NBS Building Research Division presented a survey of the methods that can be applied to the quantitative measurement of the chemical and physical properties of plastics in general. Specific techniques for the mathematical prediction and measurement of physical changes in laminates were discussed by M. M. Epstein of the Battelle Memorial Institute, while L. R. Perkins, of E. I. duPont de Nemours & Co., spoke on the chemical changes in polyethylene. R. C. Wendt, E. I. duPont de Nemours & Co., described a method of interpreting visual changes in plastics and relating such changes to chalking.

The problems connected with measurement of radiant energy used in weathering studies were brought out by three speakers. N. Z. Searle, American Cyanamid Co., stressed the measurement of spectral energy distribution of sunlight and artificial light and showed the sensitivity of plastics to changes in the radiant energy spectrum. The monitoring of sunlight and laboratory weathering lamps was covered in papers by G. C. Newland, Tennessee Eastman Co., and J. E. Clark, MCA Research Associate at NBS.

A group of three papers dealt with the accumulation and mathematical treatment of weathering data. Robert Saxon, American Cyanamid Co., pointed out some of the variables of weathering testing and presented the mathematical approaches which can be used to evaluate these variables. H. Grinsfelder, Rohm & Haas Co., covered some statistical methods to evaluate weathering data, and A. R. McGarvey of the Armstrong Cork Co., presented a simplified system for data handling and retrieval from a relatively large weathering program.

The weatherability of specific plastic formulations was the subject of eight papers. The many techniques presented in this group of papers pointed out the need for standard evaluation methods.

Four papers were devoted to weathering studies of polyolefins. These were presented by H. M. Quackenbos, Union Carbide Corp.; F. H. McTigue, Hercules Company, Inc.; F. S. Kaufman, Jr., Sinclair-Koppers, Co.; and R. J. Martinovitch, Philips Petroleum Co.

Outdoor and laboratory weathering of poly(vinyl chloride) was the subject of three papers by V. Shafer, Quarzlampen Gesellschaft mbH; J. M. Doyle, B. F. Goodrich Chemical Co.; and G. A. Baum, M & T Chemicals, Inc.

Accelerated aging of poly(methyl methacrylate) was compared to outdoor aging of this plastic under Arizona and Florida sunlight by J. M. Gordon, J. T. Baker Chemical Co.

At a banquet, held on February 8, A. V. Astin, NBS Director, spoke briefly on the role of the Bureau, its relation to industry, and its Research Associate Program. The banquet address was given by G. L. Pitzer, President, Plastics Division, Union Carbide Corp., and Chairman, Plastics Committee, MCA. In his address, he emphasized that $1.5 billion worth of plastics are used annually and that the use of these plastics in both indoor and outdoor service is increasing in such areas as automobile accessories and finishes, building materials, boats, food containers, and toys.

Mr. Pitzer explained why the MCA sponsors a Research Associate Project at NBS to study accelerated weathering of polymers when industry does so much plastics research. He pointed out that MCA wanted to improve the means of

measurement as related to the causes and effects of plastic weathering. Mr. Pitzer stated:

> "With *means of measurement* defined as the objective, it seemed most appropriate that research leading to attainment of that objective be conducted at the National Bureau of Standards which is dedicated to the science of measurement. Furthermore, its Research Associate Program appeared to provide a good means for conducting an investigation such as that contemplated. It also was considered that other related research in progress at the Bureau of Standards might contribute to the success of this investigation."

As a part of the symposium, the attendees toured the Bureau's new facilities. They visited the NBS Museum and laboratories engaged in the following activities: color measurements, dielectrics measurements, measurement of spectral irradiation, mass spectrometry, paper research, high-energy radiation, structural testing, environmental engineering, accelerated weathering, physical testing, color stability of plastics, weathering of porcelain enamel, highway quality control, and organic coatings.

Although no preprints were available, registrants received abstracts of each paper. The Proceedings of the symposium will be published by the *Journal of Applied Polymer Science* in the International Symposia Series by John Wiley & Sons, New York. They should be available by the fall of 1967.

## NBS AND ASM COSPONSOR METALS SCIENCE FIELD DAY

The National Bureau of Standards, in cooperation with the Washington Chapter of the American Metals Society sponsored a Metals Science Field Day, Saturday, January 21, 1967, at the NBS Gaithersburg (Md.) laboratories. The field day was designed to introduce science teachers and career-minded students to the work-a-day world of the metallurgist and metal scientist. In attending Metals Science Field Day, teachers had an opportunity to witness applications of the science they teach. The students were introduced to the tools and nature of the work of the metallurgist and were thus encouraged to learn more about the qualifications and education required, as well as the opportunities offered in the field.

The program, chaired by R. W. Mebs, NBS Metallurgy Division, began with a welcoming address by M. R. Meyerson, Chief, Engineering Metallurgy Section, NBS Metallurgy Division. This was followed by a talk on the purpose of Metals Science Field Day by I. J. Feinberg, NBS Engineering Metallurgy Section, Chairman, Washington Chapter, ASM. K. B. Higbie, Office of Metallurgical Research, U.S. Bureau of Mines, then discussed the production of metals from minerals. The morning talks were concluded by G. A. Moore, NBS Metallurgy Division, speaking on the structure of metals and the control of their properties.

The afternoon session included a presentation on the preparation of useful metal products by K. M. Zwilsky, Head, Alloy Development Branch, U.S. Marine Engineering Laboratory. M. H. Peterson, Head, Marine Corrosion Section, Naval Research Laboratory, followed with a talk on the utilization of metals for deep sea applications. The talks were concluded by H. E. Frankel, Head, Materials Research and Development Branch, Goddard Space Flight Center, speaking on the utilization of metals for space exploration.

The program also included a tour of selected NBS laboratories. The visitors were shown crystal growth techniques, a laboratory where nuclear magnetic resonance studies of metals are performed, a heat-treating laboratory equipped for studies of metals in various atmospheres over wide ranges of temperature, and equipment for tensile and impact testing of structural components.

Another portion of the tour included apparatus for measurement of electrodeposited-coating thickness, equipment and specimens used in corrosion research, and a field emission microscope. In addition, equipment was on display and explanations given by NBS staff members on thermal creep in metals, quantitative microscopy, diffusion in metals, soft x-ray spectroscopy, fatigue of metals, and metallographic examination of metals.

*Dr. A. S. Melmed discusses applications of the field emission microscope in metallurgical research to Field Day visitors.*

# Photolysis of Nitrogen Compounds

### Fluorescence Identifies Reactions

Some chemical reactions take place as the result of photolysis, in which electromagnetic radiation, "light" in visible or invisible wavelengths, produces excited atoms, radicals, and molecules. This occurs when the absorbed radiation, typically in the ultraviolet range, raises the energy of a molecule to the point at which it dissociates into excited species. The latter may give off surplus energy by returning to its "ground," or minimum-energy state; such energy in the form of flourescent radiation can give scientists clues to the identity of the light-emitting chemical species.

The processes leading to the creation of excited nitric oxide (NO) by photolysis of nitrogen compounds have recently been identified at the NBS Institute for Basic Standards by spectroscopic analysis of the fluorescence emitted. The identification was made by Karl H. Welge, of the Bureau's photochemistry laboratories, in a study (supported by the Atomic Energy Commission) of excited species. The experiment consisted of subjecting gaseous nitrogen compounds to ultraviolet radiation from excited rare gases, and recording and studying the radiation given off by the energetic NO returning to its ground state.

### Photolytic Experimentation

Previous experimenters had photolyzed nitrogen compounds by means of polychromatic radiation. The many reactions taking place eventually formed excited NO in many different energy levels, the surplus energy being emitted at many wavelengths. The hodgepodge of radiation resulting so obscured details of the decomposition to individual species of NO that little was discovered in this way.

Dr. Welge irradiated gaseous nitrogen compounds and mixtures with monochromatic light, thus defining precisely the amount of energy available to NO. Considering all possible reaction paths that could be involved, Dr. Welge calculated the energies required to produce the excited states of NO capable of fluorescence. By measuring NO fluorescence wavelengths Dr. Welge was able to identify the reaction path giving rise to the observed NO fluorescence.

### Equipment

The fluorescence was studied by passing a stream of the sample gas through a reaction chamber, across which the exciting light was directed. Some of the radiation emitted at right angles to the exciting light beam passed out of the chamber and into a spectrograph to make a photographic record of the wavelengths present.

Monochromatic light to excite the sample was obtained for most measurements from glowing krypton or xenon gas, energized in a microwave discharge cavity. An absorption filter placed between the exciting light beam and the reaction chamber contained a 6-mm layer of absorbing gas between its 1.5-mm windows, transmitting only the desired wavelength.

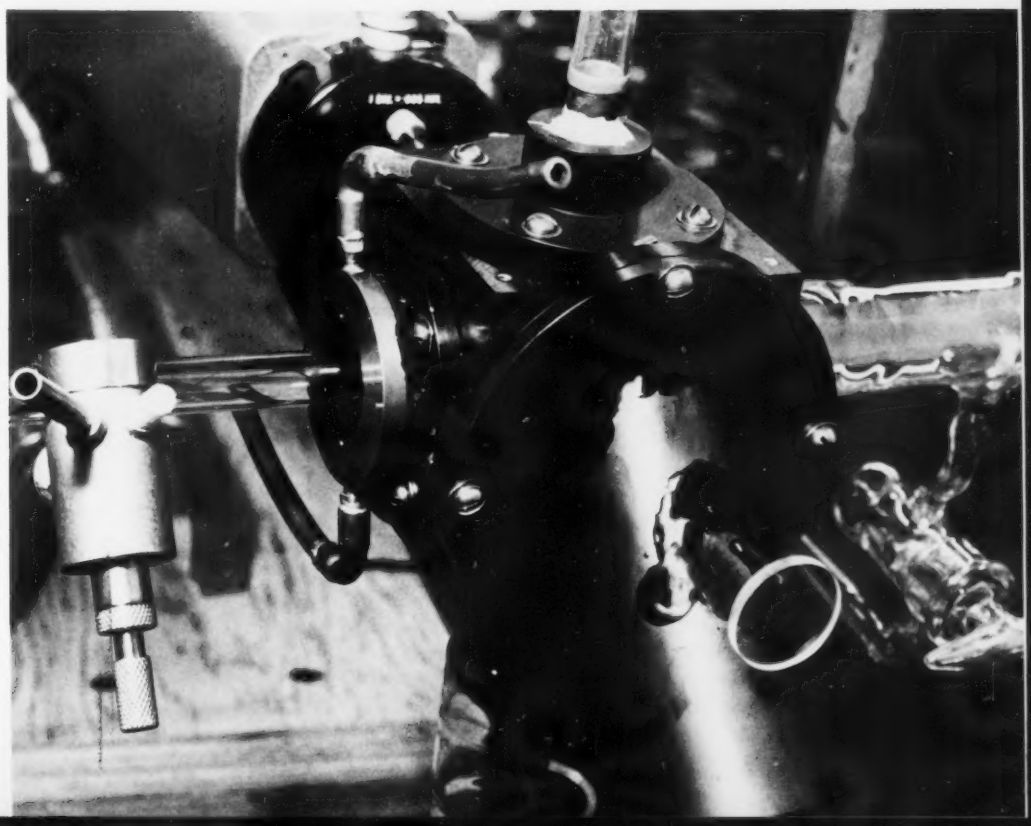
Krypton activated by the 2450-MHz discharge produces a glow at wavelengths of 1165 and 1236 Å, xenon at wavelengths of 1295 and 1470 Å. Excitation of 1216 Å was obtained from a low pressure hydrogen lamp. Excitation in the range 1600–1750 Å, $\geqq$1750 Å, and $\geqq$1600 Å was obtained from a hydrogen lamp mounted with its own quartz absorption filter at the port in front of the reaction chamber. The light flux of the krypton, xenon, and 1216–Å lines was about $1 \times 10^{15}$ quanta/sec.

The flow of the sample gas was controlled by head pressures ranging from about 0.5 $N/m^2$ (a few times $10^{-5}$ torr) to about 133 $N/m^2$. Each molecule of the sample gas had a residence time within the 1 $cm^3$ fluorescence region of about 1 msec at the maximum flow rate.

### Emission from Mixtures of $N_2O$/NO and of $HN_3$/NO

Reactions of a variety of mixtures and pressures of $N_2O$, $NO_2$, NO, $O_2$, and $HN_3$ were studied under ultraviolet radiation at 1216 Å, a mixture of 1236 and 1165 Å, 1470 Å, and wavelengths greater than 1600 Å. Fluorescence of excited NO was obtained in $\beta$ and $\gamma$ bands, corresponding to different energy levels of exited NO. The $\beta$-band of NO fluorescence was obtained by photolysis of pure $N_2O$, but was replaced by $\gamma$-band fluoresence with the introduction of even small amounts of NO for all exciting radiations except those of wavelengths greater than 1600 Å.

*Hideo Okabe adjusts the spectrometer slit in experimentation on fluorescence of nitrogen compounds energized by ultraviolet radiation. The sample gas in the reaction chamber forms new species when irradiated by glowing xenon or krypton gas.*



*Reactions taking place in stimulated gases are studied by passing the gas through a reaction chamber (center) in which it is subjected to ultraviolet radiation.*

## PHOTOLYSIS *continued*

The sequence of reactions originating from $N_2O$ was suggested by Dr. Welge to produce, first, two excited forms of N ($^2D$ and/or $^2P$) which react with $N_2O$ to form activated NO (of the $B^2\Pi$ form). This NO immediately undergoes a transition to its lowest level with the emission of the $\beta$ ultraviolet radiation. In the case of the mixture of $N_2O$ and NO, however, the ground state NO ($X^2\Pi$) reacts with energized $N_2$ (of the $A^3\Sigma^+$ form, another dissociation product) to produce NO at another energy level ($A^2\Sigma_u^+$), which returns to the ground state with the emission of the $\gamma$ bands. Gamma bands were emitted also from the mixture of $HN_3$ and NO, which on photoexcitation forms an energized $N_2$; this reacts with NO to produce excited NO of the $A^2\Sigma^+$ form, and $\gamma$-band fluorescence.

### Emission from Excited $NO_2$ and NOCl

Similar study of the rotational and vibrational distribution of excited NO from $NO_2$ and NOCl enabled Dr. Welge to chart the photodecomposition sequence of the triatomic molecules $NO_2$ and NOCl. Both $\beta$ and $\gamma$ bands were given off by $NO_2$ subjected to the 1165-Å—1236-Å mixture and to 1295 Å; only the $\gamma$ bands were given off by NOCl subjected to the same radiation. Intensity of the spectra was not noticeably affected by variation of rate of flow of the sample gases through the reaction chamber, indicating that the fluoresence resulted from a primary reaction.

Such radiation from the $NO_2$ is due to the presence of the ($A^2\Sigma^+$, v=0) state of NO resulting from the photodissociation of the $NO_2$. The same dissociation species (NO), excited to a variety of elevated energy states, is believed to be responsible for emission from the NOCl.

[1] Formation of $N_2(A^3\Sigma_u^+)$ and $N(^2D, ^2P)$ by dissociation of $HN_3$ and $N_2O$ and their reactions with NO and $N_2O$, by Karl H. Welge, J. Chem. Phys. 45, 166–170 (July 1, 1966).
[2] Electronically excited NO by photodissociation of $NO_2$ and NOCl, by Karl H. Welge, J. Chem. Phys. 45, 1113–1117 (Aug. 15, 1966).

# Photodetector Uniformity Increased

Many optical instruments, such as spectrophotometers, photometers, and spectroradiometers, utilize photodetectors for measurement of reflectance, transmittance, and scattering, in the examination and evaluation of materials. These instruments usually evaluate the interaction between radiation and materials by measurement of the incident and emergent radiation. In these measurements detector areal uniformity* is important for accurate measurements.

Polycrystalline as well as large-area single-crystal photodetectors are known to be nonuniform. Previously this has been corrected somewhat by employing diffusing screens and small averaging spheres. To further increase uniformity, a study was recently conducted[1] by I. Nimeroff and M. W. Finkel of the NBS Institute for Basic Standards. This investigation has shown that scanning reduces the adverse effect of areal nonuniformity of detectors to a higher degree than the previous methods.

In the NBS experimental study, both the distribution of irradiance incident upon the detector and areal variation of the detector's responsivity were conceptionally viewed as statistically independent random variables with voltage output amplitude a function of time. It was then shown mathematically that scanning substantially reduces the effect of nonuniformity. This was possible because ordinarily each detector element sees but one signal element, whereas scanning, even if it involves only a single pass, exposes each signal element to all the detector elements.

It was found that orientation (scan direction) is important in obtaining accurate measurements. The preferred orientation was determined from a sensitivity contour of the detector. This contour was found by masking all of the detector except a small area whose responsivity was measured. Each area of the detector was then measured in turn, revealing a sensitivity pattern. Integrations were performed by using a planimeter to measure the area under the curves. With the detector in a preferred orientation, the 11 percent error in uniformity obtained by using a small averaging sphere was consistently reduced to about 4 percent by scanning.

The results of the NBS study indicate that scanning significantly improves detector performance and can be achieved by the simple process of mounting the detector on a moving carriage. The scanning process may be applied with equal results to either multi-element or mosaic type detectors.

[1] For further information, see **A method for attaining detector areal uniformity**, by M. W. Finkel and I. Nimeroff, J. Opt. Soc. Am. (to be published).
* Same responsivity for all elemental areas of a detector.

*Dr. Lewis M. Branscomb holds the bronze plaque of the Samuel Wesley Stratton Award presented to him by Dr. A. V. Astin.*

# STRATTON and ROSA Awards Presented

On January 6, 1967, Dr. A. V. Astin, NBS Director, presented the 1966 Samuel Wesley Stratton Award to Dr. Lewis M. Branscomb for "outstanding contributions and sustained leadership in the field of atomic and molecular physics"; and the Edward B. Rosa Award to Malcolm W. Jensen "in recognition of distinguished leadership in weights and measures administration and in the development of improved techniques for product standardization." Both of these annual awards consist of a bronze plaque and a $1,500 honorarium.

The Stratton Award, founded in 1960 and first given in 1962, is named for the first Director of the National Bureau of Standards. In 1901, Dr. Samuel Wesley Stratton set about to organize NBS as a unique scientific institution. During his 21-year tenure of office, he firmly established the Bureau's position in the scientific and industrial community. Dr. Stratton left NBS in 1922 to become the ninth president of Massachusetts Institute of Technology. Each year, before the award is made, advisors from outside the Bureau are consulted in order to assure objectivity in the selection of the staff member or members whose achievements contribute most in support of the NBS mission.

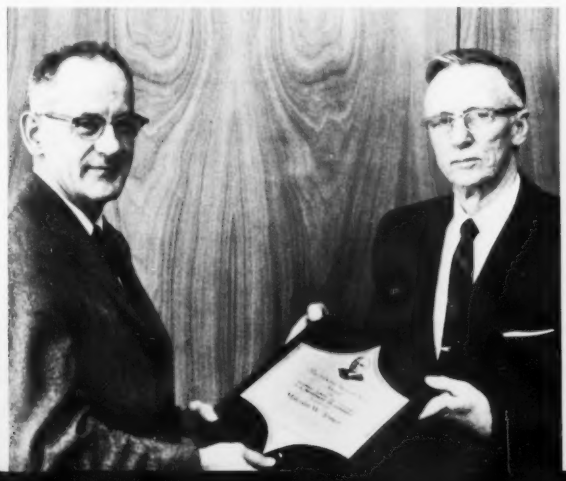
Dr. Branscomb is Chief of the Bureau's Laboratory Astrophysics Division at the Joint Institute for Laboratory Astrophysics (JILA) in Boulder, Colo. JILA is operated on a cooperative basis between NBS and the University of Colorado, where Dr. Branscomb is also a professor of physics. A member of the President's Science Advisory Committee, Dr. Branscomb is a former Chief of the Atomic Physics Division. He has been the recipient of a Rockefeller Public Service Award, a Commerce Department Exceptional Service Award, and an award from the Washington Academy of Sciences.

The Rosa Award, first given for 1964, was named for Dr. Edward B. Rosa, a member of the Bureau's original staff and its first Chief Physicist. Throughout his career, Dr. Rosa was active in the development of standards of practice and made important original contributions to fundamental standards in the field of electricity and photometry. The Award gives recognition to outstanding accomplishments in the field of standards of practice—the standards by which industry judges its operations, its production processes, and the quality of its products. The technical and committee work on standards of practice are exceedingly demanding, requiring the highest degree of technical competence and administrative skill.

Mr. Jensen is Manager, Engineering Standards, and Chief of the NBS Office of Weights and Measures which coordinates the weights and measures activities of the States and provides them with technical assistance. Its mission is to increase the uniformity of weights and measures activities throughout the country. Mr. Jensen has given strong and creative leadership to the broad range of consulting services which the office provides to State and local weights and measures administrators. These services include the drafting of model weights and measures legislation for voluntary adoption by the States, developing specifications and test methods for weighing and measuring devices, designing testing equipment, providing technical training for weights and measures officials, and comparing State standards against the national standards.

Mrs. Jensen accepted the honorarium for her husband, who was in the hospital recovering from an operation. The plaque was presented to him on March 17, 1967.

*Dr. A. V. Astin presents the Edward Bennett Rosa Plaque to Malcomb W. Jensen.*



# STANDARD REFERENCE MATERIALS

The NBS Office of Standard Reference Materials has recently issued six new standards: two materials of certified purity, two basic open-hearth steels, and two new glasses. NBS prepares and distributes standard reference materials as part of its responsibility for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. By providing the well-characterized materials needed to calibrate a measurement system, the Bureau enables laboratories and individual workers to evaluate the accuracy of their methods and encourages them to devise new and improved methods and instruments.[1]

## MATERIALS OF CERTIFIED PURITY

Materials research is highly dependent upon specially purified materials both for measurements and as starting points for the ultra purification procedures necessary in this field. Reagent grade materials vary markedly with supplier and with the origin of the raw materials in regard to either trace impurities, contaminants, or both. This means that each research worker must establish his own criterion of purity and obtain a source of the purified material. He must characterize the material before he can start his experimental work.

As part of the NBS Standard Reference Materials program, the Bureau obtains a large supply of high-homogeneity material, generally 5 to 10 times purer than reagent grade material. This material is carefully characterized as to chemical composition and homogeneity and is certified as to purity. These materials of certified purity are then made available to research workers as starting materials.

Materials of certified purity are not ultra-high-purity materials. They are intended to bridge the gap between commercial materials presently available in bulk and the ultra-high-purity single-crystal materials. They should be of special interest to the small research laboratory or individual research worker having available a minimum of characterization resources.

The first of these materials to be certified and made available was NBS Standard No. 726, Intermediate Purity Selenium. In the form of pellets one-eighth inch in diameter, the standard is sold in 1-pound units for $40 each.

The second material, rubidium chloride, is of natural ratio isotopic composition, and has been prepared and issued as NBS Standard No. 727. It was certified January 20, 1967. Units of 1 gram are priced at $20 each. This new standard was prepared for specialized uses in the nuclear and defense industries which require small quantities of the homogeneous, carefully characterized compound to provide a reference point in their measurement system.

## STEEL STANDARDS CERTIFIED FOR CARBON ONLY

Two new steel standards were prepared and certified for carbon only. They are designed for calibrating and checking a rapid carbon analyzer widely used in production control and customer acceptance of steel with respect to the carbon content.

The standards, in chip form, are designated NBS Standard No. 335, Basic Open-Hearth Steel, 0.1 percent (carbon only), and NBS Standard No. 337, Basic Open-Hearth Steel, 1. nt (carbon only), and cost $5 each. This price comp with prices of $12 and $15 for the multipurpose chip form steel standards certified for several elements.

The two new standards are single-element standards that have been prepared to conserve previously issued steel standards which were certified for multiple elements, usually including carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, chromium, vanadium, and molybdenum. The new rapid carbon analyzer, which reduces the elapsed time for a carbon determination and permits control of carbon content in steel production, requires frequent checking and calibration. Recent widespread acceptance of this instrument by industry upset estimates of demands for the multi-element steel standards. Sales increased more than 100 percent, and for a few, the increase was near 300 percent, thus threatening to require renewal of the multi-element standards in one-third to one-half of the normal length of time.

To eliminate the expense, especially in terms of manpower, at NBS and in industry for the analytical work required to certify multi-element standards, steps were taken to prepare a low- and high-carbon steel to be certified for carbon only to fill this specific need for a calibration reference.

Supplied in 150-gram units, sized between 16 and 40 mesh sieves, the standards were prepared from selected portions of commercial ingots. Material for No. 335 was supplied by the Jones & Laughlin Steel Corp., and for No. 337 by the United States Steel Corp. The certified carbon values are based on analytical results from the National Bureau of Standards with cooperative results reported from the laboratories of Armco Steel Corp., Inland Steel Co., American Cast Iron Pipe Co., and the General Motors Corp.

The certificate accompanying each standard includes individual carbon values reported by each cooperating laboratory and indicates the method by which it was obtained.

The NBS Office of Standard Reference Materials would appreciate comments from persons in the metals field concerning these standards. Suggestions for other materials that should be certified on a single- or multi-element basis will be welcomed.

## GLASS STANDARDS

Two additional glass standards designated NBS Standard Nos. 715 and 716 have been made available. The glasses were donated to NBS by Owens-Illinois, Toledo, Ohio. They have been calibrated at NBS for softening, annealing, and strain points by staff members A. Napolitano and E. G. Hawkins, in collaboration with the laboratories of the Corning Glass Works, Corning, N.Y., and of Owens-Illinois. ASTM test methods C338–57 and C336–64T, were used for these measurements.

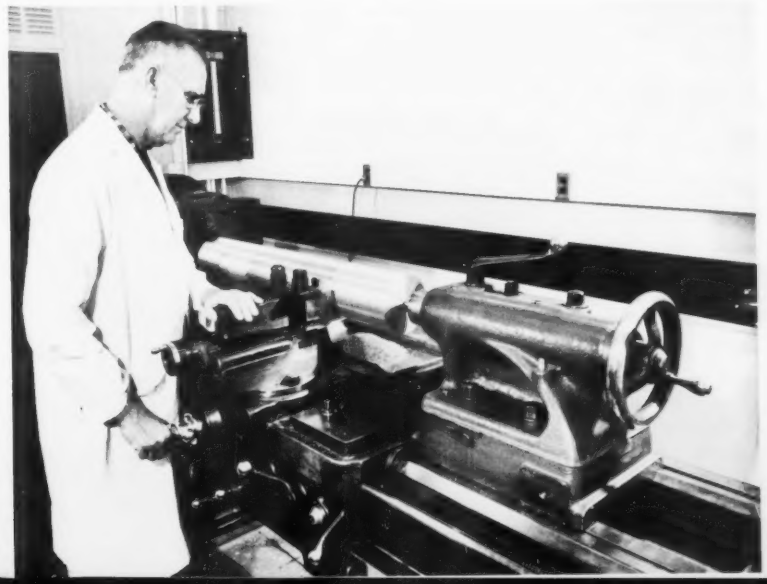
These new standard materials complete the series of standard glasses, NBS Standard Nos. 710–716.[2] Originally proposed for softening, annealing, and strain point standards, the glasses cover a range of compositions from "soft" to "hard" glasses and are representative of many of the types of glasses now being manufactured commercially by the glass industry. The seven standard glasses in the series have softening points ranging from 528 to 961 °C and annealing points ranging from 386 to 764 °C.

The two new glass standards are commercial-type glasses and cost $25 each. NBS Standard No. 715 is an alkali-free aluminosilicate glass issued in 13 pieces or "canes" 15 cm long and 0.6 cm in diameter (6 x ¼ inch) weighing approximately 200 grams. NBS Standard No. 716 is a neutral (borosilicate) glass issued in 6 pieces or "canes" 15 cm long and 1.2 cm in diameter (6 x ½ inch) weighing approximately 250 grams.

The softening, annealing, and strain points are certified and information on such other physical properties as thermal expansion, density, modulus of elasticity, and refractive index is provided by the certificates. The softening and annealing points are used regularly in the manufacture of glass and glass objects for quality control and for outlining annealing practices. They provide common reference sources for glass of the same or similar chemical composition and they may be used to check and calibrate furnaces defined by ASTM specifications for softening, annealing, and strain point measurements.

[1] For a complete list of NBS standards, see **Standard Reference Materials: Catalog and Price List of Standard Materials Issued by the National Bureau of Standards**, NBS Misc. Publ. 260, for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for 45 cents.

[2] **Viscosity standard sample of glass**, NBS Tech. News Bull. **46**, No. 11, 175 (Nov. 1962); **New glass viscosity standard**, NBS Tech. News Bull. **49**, No. 3, 43 (March 1965); **New glass standards**, NBS Tech. News Bull. **50**, No. 6, 92 (June 1966).



*The chips milled from this homogeneous bar of plain carbon steel are sized between 16 and 40 mesh sieves and issued as NBS Standard No. 335, Basic Open-Hearth Steel, 0.1 percent carbon.*

# NSRDS NEWS

*This column regularly reports significant developments in the program of the National Standard Reference Data System. The NSRDS was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data.*

### Chemical Thermodynamics Data Group

Since 1940, the Chemical Thermodynamics Data Group at NBS has grown from a single worker to a staff of eight chemists and a clerk. D. D. Wagman heads the group which has as its principal mission the evaluation and compilation of thermochemical and thermophysical properties of chemical substances in gas, liquid, and solid phases to provide self-consistent tables of "best" values of enthalpy, Gibbs free energy of formation, entropy, heat capacity, and phase change properties for chemical compounds. In addition to evaluating data, this group also prepares the Inorganic Substance—Property Index and Bibliography for the annual IUPAC-sponsored *Bulletin of Thermodynamics and Thermochemistry*. The entire world technical community is served because these data are basic to any technical activity concerned with the energetics of chemical transformations.

F. R. Bichowsky of the Naval Research Laboratory was the first to evaluate and compile a self-consistent set of thermochemical data and these data were published in the section on thermochemistry in Volume V of the *International Critical Tables* (1929). In collaboration with F. D. Rossini of NBS, Dr. Bichowsky revised and extended these tables in 1936. At Dr. Rossini's urging, a formal activity within the Bureau was established in 1940 to revise and extend chemical thermodynamic data, but World War II interrupted the work and it was not resumed until 1946. From March 1947 to March 1950, the updated and extended tables were issued quarterly in looseleaf form, without references. Distribution was limited to 1 set per laboratory in industry, educational institutions, and other organizations for a total of 1,700 sets. In 1952, the revised looseleaf pages, plus references, were published in book form as NBS Circular 500, which was reissued in 1961 for a total distribution of 4,500 copies.

NBS Circular 500 is now being revised by the Chemical Thermodynamics Data Group to meet the increasing demand and need in the scientific community for a more current, self-consistent set of thermodynamic data for chemical substances. The revision is being issued piecemeal as parts of NBS Technical Note 270. Already published are Technical Note 270–1, *Selected Values of Chemical Thermodynamic Properties, Part 1. Tables for the First Twenty-Three Elements in the Standard Order of Arrangement*,[1] and 270–2, *Tables for the Elements Twenty-Three Through Thirty-Two in the Standard Order of Arrangement*.[1] As additional revised tables are completed they will be published in the Technical Note 270 series. After the entire tables have been revised they will be published as part of the NSRDS critically evaluated compilation series.

### Toward a General-Purpose Code System for Scientific Documents

Blanton C. Duncan of the Physical Chemistry Division is responsible for the development of the taxywriter (NSRDS News, TNB, July 1966), which is a modified tape typewriter for use as an input device for the preparation of machine-readable records. With this device he is attempting to record scientific text in machine language, providing accurate representation of the nonnumeric portions.

The taxywriter is a principal component of a system whose primary objective is to improve by mechanization the day-by-day operations of the Chemical Thermodynamics Data Group activity (above). This mechanized system should prove valuable in the preparation of copy for computer-aided publication, but its primary use here is to improve the efficiency of producing and using files of 3 x 5 cards. The continued usefulness of a manual file system for rapidly and easily locating single data points, and for critical evaluation of data entries, should not be underestimated.

Mechanization in file preparation offers considerable

*(Top) William Evans and Vivian Parker of the Chemical Thermodynamics Data Group examine a graphically smoothed set of data on the heats of dilution of magnesium chloride. (Bottom) Another member of the Group, Tom Jobe (foreground) abstracts a recent publication while (rear, l. to r.) Joan Soblotne and Rachel Dudley plan the preparation of the annual Bulletin of Thermodynamics and Thermochemistry.*

advantages. For instance, a single abstract generally yields 10 or more handwritten file cards. Each of these cards contains information which is largely identical to that on every other card of the set. In a mechanized system, where the set of cards for each abstract is machine generated and printed, an analyst need mark only the abstract and is spared manual preparation of each file card. This saves a considerable amount of professional staff time, produces legible file cards, and provides data in form suitable for manipulation and search in a mechanized system.

The purpose of mechanizing basic data and reference files is to enable:

(1) The scientist to prepare his written material with minimum interference to his usual recording method;

(2) An ordinary typist to work at a familiar device that requires no special training of the operator; and

(3) The digitizing of the recorded information for machine use at the first typing.

The taxywriter accomplishes these objectives by providing the machine function of a man-machine input system that minimizes demands upon the man (scientist or typist) while augmenting his effort efficiently at low initial cost.

The scientist records what he wishes with the full range of scientific symbolism to which he is accustomed (Greek alphabet, brackets, special symbols, mathematical notation). The typist prepares typewritten copy exactly duplicating the handwritten manuscript with the aid of familiar typeface units individually inserted at the platen. Halfspacing in the vertical direction permits the typist to join brackets, to make super and subscripts, and special symbols. Backspacing provides a variety of graphics by underscoring and overstriking. The byproduct paper tape contains a record that enables a computer to develop the exact image of the typewritten page including all graphic elements used in their proper coordinate location.

The manuscript image is stored by the computer in a general purpose scientific document code. After retrieval from this storage, the manuscript image can be output to the taxywriter, to a high-speed printer (with approximately 200 graphics), and to photocomposition devices.

Although this system was developed to meet specific needs of the Chemical Thermodynamics Data Group, the general character of the input device, the use of a generalized code, and the variety of output devices suggest that broader usage is possible and feasible.

### Infrared Spectral Data—Mission Accomplished

Disposition of residual infrared spectral data from the now-terminated National Research Council-National Bureau of Standards Spectral Data Project (NSRDS News, TNB, August 1966) has been completed. The intention of the Office of Standard Reference Data was to distribute the remaining sets of spectra to institutions with limited financial and reference resources.

*continued*

## NSRDS NEWS *continued*

Response to the announcement was most gratifying, although it also created some problems for this Office. Over 100 requests for the spectral data collection were received of which the great majority were from organizations meeting the above-stated general qualifications to receive the spectra.

Forty complete sets of 2,510 spectra were distributed on a "first come, first served" basis. In addition, fifteen incomplete sets of mixed sheets and cards, each totaling about 2,000 spectra, were also distributed on that basis and should be valuable to the recipients.

The Office of Standard Reference Data extends its thanks to all respondents who showed interest in the spectra, and its sincere regrets to those it had to disappoint.

### CODEN

The Office of Standard Reference Data is taking an active interest in the use of CODEN for information exchange among data centers.

The five letter symbols designating titles of periodicals and known as CODEN have become increasingly popular, especially since their adoption by the American Chemical Society as items of information regularly furnished with literature references. The maintenance of this system of codes, the assignment of new codes to new or hitherto omitted periodical titles, the searching of files for previous assignments, and the answering of requests for information, represent an exacting task, which was performed for years by Charles Bishop, the originator of the system, and more recently by L. H. Kuentzel of the Wyandotte Chemical Corp., under the auspices of the American Society for Testing and Materials.

The CODEN system is likely to be of decisive assistance in large-scale bibliographic work and especially in mechanized bibliographic systems. For these reasons CODEN plays an important role in NSRDS.

Currently a number of new developments are under consideration. One of these is the contemplated transfer of the responsibility for maintenance from Wyandotte to the Franklin Institute. The transfer is planned in such a way as to result initially in no changes in the existing system. It is anticipated that there will be increased emphasis on assigning codes systematically to all important journals, instead of making assignments mainly on request as has been done in the past. Changes for the future, which are being discussed tentatively at present, include the assignment of codes to publishers and to report series, as a step toward reaching the nonperiodical literature and information not in the published literature.

### Papers on Compilations of Data Published

Much of the February 1967 issue of *Journal of Chemical Documentation* was devoted to the papers presented at the 152d National Meeting of the American Chemical Society, "Symposium on Compilations of Data on Chemical and Physical Properties of Substances," E. L. Brady, Chief of the Office of Standard Reference Data, organized this Symposium for the Division of Chemical Literature of the American Chemical Society.

The following papers were included:

"Historical Background of Current Data Compilation Activities," by F. D. Rossini; "The National Standard Reference Data System," by E. L. Brady; "Needs of ACS Members for Property Data," by H. M. Weisman; "NSRDS Program in Atomic and Molecular Properties," by S. A. Rossmassler; "Data Compilation Activities in the United Kingdom," by R. M. S. Hall; "A World System of Data Compilations," by G. Waddington; "Organizing Physical Molecular Data for Qualitative Chemical Analysis," by L. Kuentzel; "Numerical Data Activities in Engineering Societies," by F. Y. Speight; "The NBS Chemical Kinetics Information Center," by D. Garvin; and "The Radiation Chemistry Data Center," by A. B. Ross and M. Burton.

A limited number of sets of reprints of these papers are available from the Office of Standard Reference Data.

### Discussion Forum, Data and Information Center Operators

A meeting of all data and information center operators associated with the Office of Standard Reference Data was held April 6–7, 1967, at the NBS Gaithersburg laboratories. Fifteen data and information centers within and nine centers outside the Bureau participated in the forum. The major objectives of the meeting were: (1) To examine and develop machinery for communication exchanges and work sharing; (2) to explore means for establishing compatibility among operational procedures of the centers; (3) to explore and help formulate standards of quality; and (4) to define relationships between and among the Office of Standard Reference Data and associated centers and to develop machinery for more effective aid to the centers.

### Engineers Joint Council Committee on Data Storage and Retrieval

The Engineers Joint Council recently formed a committee on storage and retrieval of engineering data as part of its overall program to improve information services for the engineering community. Howard J. White of the Office of Standard Reference Data is participating in the work of this committee to acquaint the Engineers Joint Council with relevant activities within NSRDS and, at the same time, to provide information to NSRDS on the needs and problems of the engineering community.

[1] For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for the price indicated: NBS Tech. Note 270–1, 65 cents; NBS Tech. Note 270–2, 40 cents.

# PUBLICATIONS of the National Bureau of Standards*

## PERIODICALS

*Technical News Bulletin*, Volume **51**, No. 3, March 1967. 15 cents.
Annual subscription: $1.50. 75 cents additional for foreign mailing.
Available on a 1-, 2-, or 3-year subscription basis.

*Journal of Research of the National Bureau of Standards*
*Section A. Physics and Chemistry.* Issued six times a year. Annual subscription: Domestic, $5; foreign, $6. Single copy, $1.00.
*Section B. Mathematics and Mathematical Physics.* Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.
*Section C. Engineering and Instrumentation.* Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

## CURRENT ISSUES OF THE JOURNAL OF RESEARCH

*J. Res. NBS* **71A** (Phys. and Chem.), No. 2 (Mar.–Apr. 1967), $1.00.

Relative enthalpy of beryllium 1 : 1-aluminate, $BeO \cdot Al_2O_3$, from 273 to 1173 °K. Thermodynamic properties from 273 to 2150 °K. D. A. Ditmars and T. B. Douglas.

Relative enthalpy of beryllium 1 : 3-aluminate, $BeO \cdot 3Al_2O_3$, from 273 to 1173 °K. Thermodynamic properties from 273 to 2150 °K. D. A. Ditmars and T. B. Douglas.

The heats of combustion of polytetrafluoroethylene (Teflon) and graphite in elemental fluorine. E. S. Domalski and G. T. Armstrong.

Phase relations in the systems $TiO_2$-$IrO_2$ and $SnO_2$-$IrO_2$ in air. C. L. McDaniel and S. J. Schneider.

Sample purity and the N.Q.R. of $Cl^{35}$ in $KClO_3$ at 0 °C. D. B. Utton.

Techniques for the growth of large single crystals of potassium of high purity. H. J. Foster and P. H. E. Meijer.

Synthesis of α-L-fucose-l-$^{14}$C (6-deoxy-L-galactose-l-$^{14}$C). H. S. Isbell, H. L. Frush, and N. B. Holt.

Deuterium isotopes effects in α-β in the pyranose-furanose interconversions. H. S. Isbell and C. W. R. Wade.

Calculated transition strengths between the configurations $5d^8$ 6s and $5d^9$ 6p in Au III. H. Mendlowitz.

Hartree-Fock multiplet strengths for K I, Ca II, and Sc III. A. W. Weiss.

Oscillator strengths for the helium isoelectronic sequence. A. W. Weiss.

Solvent effects on the ultraviolet absorption of polystyrene. V. M. Story, D. McIntyre, and J. H. O'Mara.

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Porcelain enameled formed steel plumbing fixtures, PS5–66 (Nov. 1, 1966), 15 cents. Supersedes CS144–47.

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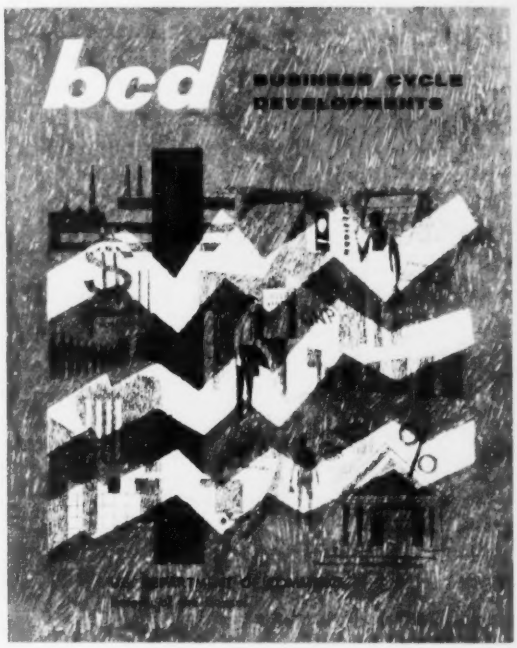


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